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FIXED VS. VARIABLE ENVIRONMENTAL STANDARDS

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FIXED VS. VARIABLE ENVIRONMENTAL STANDARDS

Presented at

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By

ROBERT P. PIKUL

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The purpose of this paper is to provide a frame of reference for discussion of fixed vs. variable standards and to generally explore some potential social and economic consequences of allowing variable standards. It will be shown that effluent or emission standards particularly, exhibit both fixed as well as variable properties based on parameters such as time, geographical area and source category. Present variability in standards generally results from independent analyses of individual pollutants and individual source categories. Because of the vital issues related to the levels and nature of environmental standards, their variability should result from an explicit consideration of emission control strategies aimed at achieving well defined environmental quality goals.

The implications of variable standards are discussed within the context of the air pollution problem as a specific illustration.

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FOREWORD

This paper represents work performed by The MITRE Corporation in support of the Strategic Environmental Assessment System (SEAS) Project sponsored by the Environmental Studies Division of the Environmental Protection Agency under Contract No. 68-01-1849. The work reported herein relates to Item C in the Statement of Work which pertains to investigation of procedures for establishing environmental standards.

The SEAS Program is presently being designed and tested through the combined efforts of the Environmental Studies Division of the Office of Research and Monitoring, Environmental Protection Agency; its several contractors: CONSAD Research Corporation; International Research and Technology Corporation; International Business Machines/ Federal Systems Division, and The MITRE Corporation; and private consultants.

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SECTION I

INTRODUCTION

PURPOSE

The established nature and enforcement of environmental standards will have a far reaching impact on future socio-economic-environmental characteristics of geographical areas, availability and cost of energy, revitalization of urban areas and overall quality of life.

Environmental standards have been and are being formulated by the U. S. Environmental Protection Agency, the states and local governments for a variety of pollutants which are released into air, water and land media. The process requires consideration of items such as effects (health, economic, ecological), measurement techniques, current environmental levels, pollution sources, and the technology and economics of control. A variety of procedures based on factors such as legislative authority, technical problems and administrative requirements have been devised and implemented by organizations responsible for development of standards[2,3].

The purpose of this paper is to provide a frame of reference for discussion of fixed vs. variable standards and to generally explore some potential social and economic consequences of allowing variable standards. It will be shown that effluent or emission standards particularly, exhibit both fixed as well as variable properties based on parameters such as time, geographical area and source category. Present variability in standards generally results from independent analyses of individual

pollutants and individual source categories. Because of the vital issues related to the levels and nature of environmental standards, their variability should result from an explicit consideration of emission control strategies aimed at achieving well defined environmental quality goals.

The implications of variable standards are discussed within the context of the air pollution problem as a specific illustration.

CONCEPT OF FIXED VS. VARIABLE STANDARDS

The initial reaction of the reader to the concept of fixed vs. variable standards may be one of confusion as to meaning. This arises because of the large number of parameters which affect proper interpretation. For example, the concept pertains to variability (or invariability) with respect to time, space, among source categories and within source categories. Furthermore, one considers standards for environmental quality levels which pertain to ground level concentration (or amount of pollutant in a given volume of the medium) as well as effluent standards which pertain to amount of pollutant discharge per unit of time, raw or processed material, or energy consumed or produced.

Time Variation

Variation in time could be represented by the point in time at which standards are to be achieved or the ability to vary ambient or emission standards over a relatively short period (e.g., seasonally, daily). A short time period is arbitrarily assumed in this paper to emphasize short term discretionary changes in standards based upon risks, suitable control techniques and profile of available resources as opposed to long term

schedule of achievement fixed by law based upon perceived need for improving environmental quality. A general relationship between varying ambient levels and time lagged controlled emissions is shown in Figure 1.

Space Variation

This parameter refers to the possibility of allowing different standards in different geographical areas, in recognition of social values, geographical and climatic differences, population density, and the like. It includes the option of allowing one level of power plant emissions in a municipality, a different (e.g., less stringent) level within a parent county and still a different level on a statewide basis. It also includes the option of promulgating different standards for different sections of the country (e.g., northeastern U.S. vs. southwestern U.S.). Space variability of environmental standards is shown in Figure 2.

Variation Among Source Categories

Variation among source categories applies to emissions or discharges allowed for various emitter categories which emit the same type of pollutant (e.g., steam electric generating plants, sulfuric acid plants). The EPA has prepared effluent guidance documents for 21 industries under the 1972 Federal Water Pollution Control Act[26], which identifies 27 industries for which effluent guidelines must be prepared (Table I). The EPA feels that guidelines are required for an additional 15 areas (Table II). According to these guidelines, discharges are generally fixed in time and space. For a specific pollutant, however, they are variable among defined categories of sources.

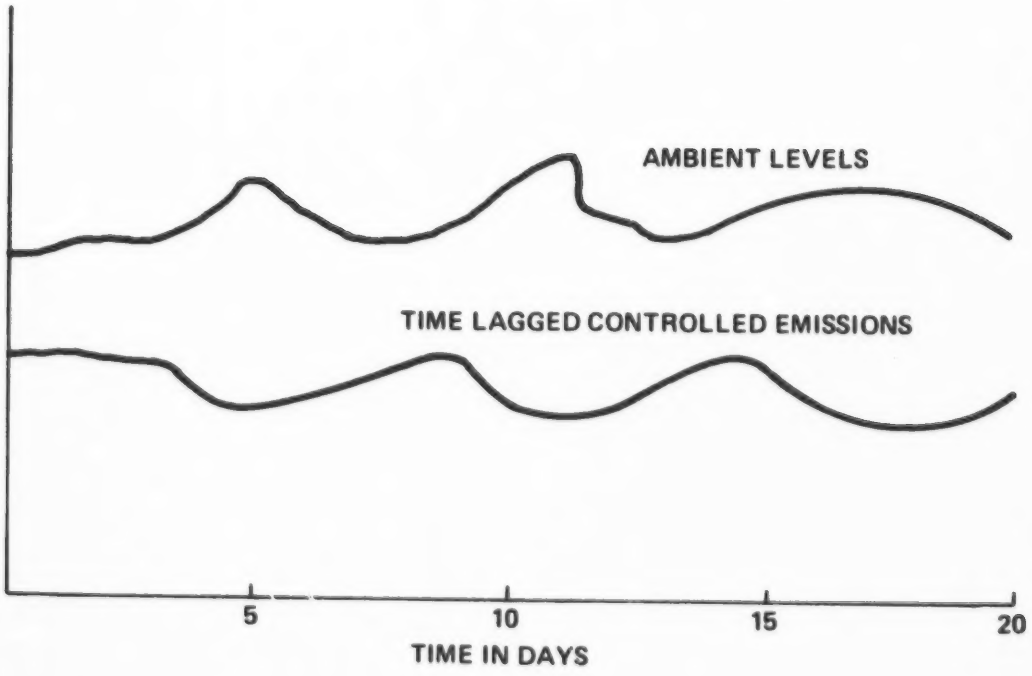

FIGURE 1

ILLUSTRATION OF TIME VARIABLE EMISSION STANDARDS

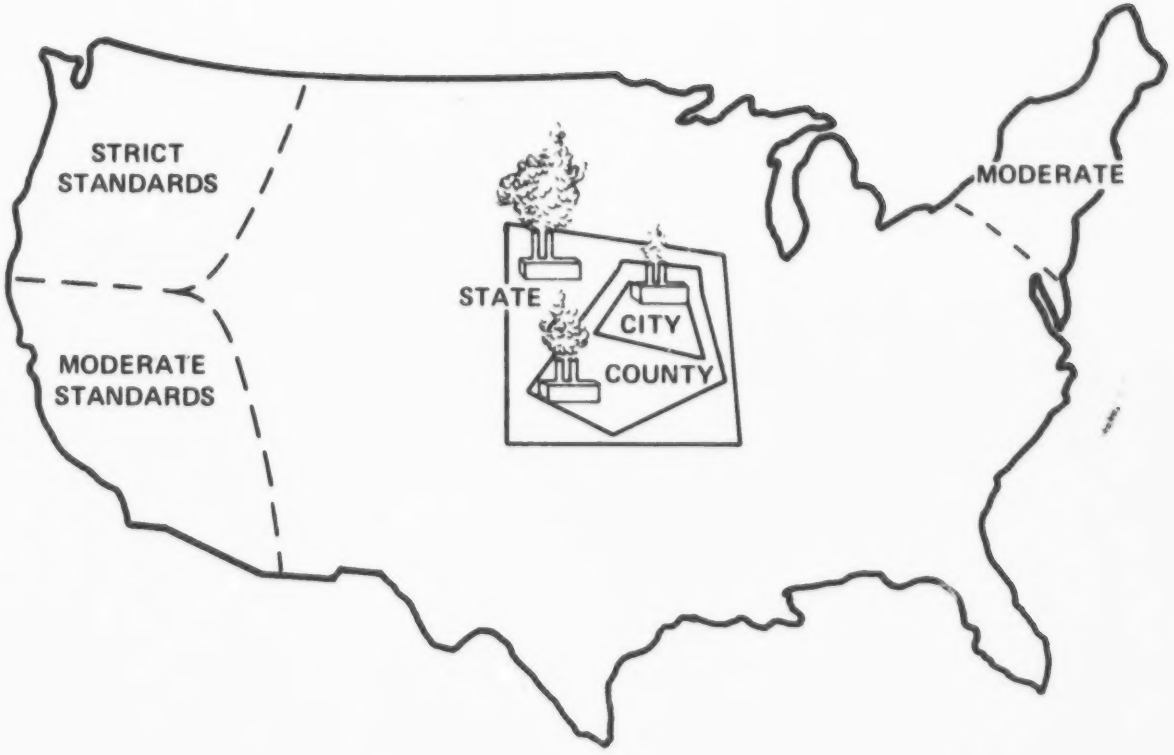

FIGURE 2

ILLUSTRATION OF SPACE VARIABLE ENVIRONMENTAL STANDARDS

TABLE I

INDUSTRIAL CATEGORIES FOR EFFLUENT GUIDANCE ACCORDING TO 1972 FEDERAL WATER POLLUTION CONTROL ACT

- Canned Fruits and Vegetables
- Canned Seafood
- Cement Manufacturing
- Dairy Products Processing
- Electroplating
- Feedlots
- Ferroalloy Manufacturing
- Fertilizer
- Glass and Asbestos
- Grain Mills
- Inorganic Chemical Manufacturing
- Iron and Steel Manufacturing
- Leather Tanning
- Meat Products and Rendering
- Nonferrous Metals
- Organic Chemicals Manufacturing
- Paperboard and Builders Paper
- Petroleum Refining
- Phosphate Manufacturing
- Plastics and Synthetics
- Pulp and Paper Mills
- Rubber Processing
- Soap and Detergents
- Steam Electric Power
- Sugar Processing
- Textile Mills
- Timber Products

TABLE II

ADDITIONAL CATEGORIES FOR WHICH EFFLUENT GUIDANCE IS REQUIRED

- Beverages
- Cane Sugar
- Coal Mining
- Fiberglass Insulation
- Fish Hatcheries
- Metal Ores
- Motor Vehicles
- Natural Gas Liquids
- Paints
- Pesticides
- Petroleum Drilling
- Pharmaceuticals
- Photo Processing
- Sand and Gravel
- Water Supply

Variation Within Source Categories

This parameter allows for the possibility of different emission or discharge levels for specific selected sources within a category. Limitation of sulfur dioxide emissions per unit energy from a specific power plant, for example, would be allowed to differ from that of other power plants in a given locale based upon plant characteristics such as age, boiler type and stack size. An illustration of this variability applies to the effluent guidelines mentioned above in that they are meant to apply to the most significant polluters.

Variation by Use

When one considers the specific area of water pollution a major element affecting variation of standards is use of the water receiving the effluent.

Uses generally conform to the following categories:

- Public Water Supply
- Industrial Water Supply
- Propagation of Aquatic Life
- Water Contact Recreation

Not only do standards for a particular pollutant vary among use levels in different geographic areas, but the use levels themselves vary from state to state. For example, Illinois at one extreme, has defined only two use categories while Missouri has defined 17[15,27]. These are shown in Table III. Water quality standards are fixed in time once they are implemented, but variable over geographical areas and by use. For

TABLE III

DESIGNATIONS OF WATER USE FOR TWO STATES

ILLINOIS	MISSOURI
1. General Use (aquatic life, agricultural use, primary and secondary contact use, most industrial uses, and aesthetic).	1. Irrigation.
2. Public and Food Processing Water Supply.	2. Livestock Watering.
	3. Propagation of Commercial Fish.
	4. Propagation of Warm Water Sport Fish.
	5. Propagation of Cold Water Sport Fish.
	6. Wildlife Watering.
	7. Industrial Cooling Water.
	8. Industrial Process Water.
	9. Drinking Water Supply.
	10. Hydroelectric Power.
	11. Boating and Canoeing.
	12. Fishing.
	13. Whole Body Water Contact Recreation.
	14. Aesthetic Value.
	15. Receive Effluents.
	16. Navigation.
	17. Receive Surface Runoff.

example, as applied to the pulp and paper industry, the fecal coliform tests associated with pathogens in the effluent are generally limited to 1000 organisms per 100 milliliters of water. A reduced concentration must be achieved, however, if receiving waters are used for shellfish harvesting or contact recreation sports.

Ambient and Emission Standards

Primary ambient standards to safeguard the public health and secondary ambient standards to safeguard public welfare were promulgated in April, 1971, for six primary air pollutants: sulfur dioxide, total suspended particulates, hydrocarbons, nitrogen dioxide, carbon monoxide and total oxidants[16]. The effective date for achievement of primary standards has been set for 1975, and for secondary standards a reasonable time thereafter. The ambient standards are fixed in time and space. Former EPA Administrator William D. Ruckelshaus has indicated that the Clean Air Act does not allow for increase of the health risk upon which the primary standards were formulated[18]. Changes to allow regional variability must be achieved through legislative action.

In contrast to the fixed ambient standards, emission limitations on stationary sources have been set according to State Implementation Plans (SIP's) and vary from state-to-state, among source categories and in some instances in time. Arkansas, for instance, allows the burning of any quality fuel as long as ground level ambient standards are not exceeded. Hence, emission standards are implicit. Although any generalization in this regard is hazardous, one might interpret this to mean

that emissions could be allowed to vary during different periods of ventilation and assimilative capacity of the atmosphere as long as ambient standards are not violated. On the other hand, Alabama has an Implementation Plan which specifies .72% sulfur content for all coal burned and 1.08% sulfur for residual fuel oil. New source performance standards for utilities burning oil have been set at .72%[8].

Section 202 of the Clean Air Act specifies that emission of carbon monoxide and hydrocarbons for light duty engines and vehicles manufactured in 1975 be reduced to 90% of levels for engines manufactured in 1970. The limitations are the same for nitrogen oxides emissions for vehicles manufactured in 1976, based on levels emitted by engines in 1971. Recently, the Administrator of EPA granted a one year extension for implementation of these standards. These limits, expressed in grams per vehicle mile, will be fixed in time for all sections of the country.

Emission standards for new stationary sources have been promulgated for various pollutants as they apply to Group 1 industrial categories as shown in Table IV. Standards are being developed for sources in Groups 2 and 3. Other groups may be considered to include sources such as gas turbines, lime plants, grain milling, auto assembly plants and petroleum refineries. It is likely that these standards may be fixed in time, space, and within source category (e.g., 0.8 lbs of sulfur dioxide per million BTU for liquid fossil fuels and 1.2 lbs of sulfur dioxide per million BTU for solid fossil fuels burned in all affected new steam generating plants), but variable among categories, for a

TABLE IV

NEW SOURCE PERFORMANCE STANDARDS

	SOURCE
GROUP 1	Steam Generators >250 Million BTU/hr.
	Incinerators
	Portland Cement
	Nitric Acid Manufacture
	Sulfuric Acid Manufacture
GROUP 2	Asphalt Batch
	Petroleum F.C.C.
	Rendering Plants
	Brass and Bronze
	Basic Oxygen Furnace
	Sewage Incinerator
	Secondary Lead
GROUP 3	Non-Ferrous Smelters
	Aluminum Reduction
	Kraft Mills
	Coking Plants
	Phosphate Fertilizer
	Phosphorus Reduction
	Animal Feed Defluorination
	Ferro-alloy Plants
	Coal Cleaning Plants

particular pollutant. While total emissions from a given emitter may vary because of size of the emitter, emission rates are likely to be fixed.

Hazardous pollutant emission standards for mercury, asbestos and beryllium have been developed with reference to specific source categories and have similar space, time and source variability characteristics as new source performance standards. Other selected hazardous pollutants for which standards may be developed are shown in Table V.

Summary of Variability Characteristics

The discussion in the preceding paragraphs emphasizes that the interpretation of the concept of fixed vs. variable standards is complex because one must consider the various types of standards, the environmental medium, and time, space, source category and use level parameters. It is also evident from the disucssion that the pervasiveness of environmental standards will have a significant impact on all major industrial sectors of the country and related economic and social activities. The examples of air and water standards are sufficient to illustrate this point. A summarization of the present situation based on the preceding illustration is shown in Table VI. The designation of fixed (F) or variable (V) represents major indications rather than clear, unambiguous extremes. This summarization does provide a frame of reference for discussion in the following sections. Within this frame of reference, only the ambient standards and mobile source emission standards may be characterized as fixed.

TABLE V

SELECTED POTENTIAL HAZARDOUS POLLUTANTS

- Cadmium
- Arsenic
- Polychlorinated Biphenyl
- Nickel
- Polycyclic Organic Matter
- Aeroallergens
- Reactive Organic
- Pesticides
- Radioactive Material
- Vanadium
- Manganese
- Chromium
- Selenium
- Chlorine
- Hydrochloric Acid
- Copper
- Zinc
- Boron
- Barium
- Tin
- Phosphorous
- Lithium

TABLE VI

FIXED VS. VARIABLE STANDARDS AND GUIDELINES
FOR AIR AND WATER MEDIA

MEDIUM	STANDARD/GUIDELINE	TIME	SPACE	AMONG SOURCE CATEGORIES (UNIT RATES)	WITHIN SOURCE CATEGORIES (UNIT RATES)	USE
WATER	WATER QUALITY	F	V	—	—	V
	EFFLUENT DISCHARGE	F	F	V	V	V
AIR	AMBIENT	F	F	—	—	—
	STATIONARY SOURCE EMISSIONS (SIPs)	F	V	V	F	—
	MOBILE SOURCE EMISSIONS	F	F	--	—	—
	NEW SOURCE PERFORMANCE	F	F	V	F	—
	HAZARDOUS POLLUTANTS	F	F	V	F	—

F = Fixed
V = Variable
- = Not Applicable

SECTION II

SOME OBJECTIONS TO VARIABLE STANDARDS

Consideration of variable standards might allow some flexibility in balancing risk of exposure with potential economic, technical and social effects of implementation of control technology. In addition, a control strategy which would permit variable emission standards (e.g., selective or intermittent controls) within source categories designed in a way so as to meet ambient standards might provide some less stringent requirements for specific sources with no deterioration in environmental quality. The issues are particularly important in cities with older housing and industries where implementation of fixed standards on a uniform basis might create significant dislocation and inhibit opportunity for economic and socially viable renewal and growth.

Many reasons are offered against adopting variable standards. Some of these are discussed below.

INEQUITABLE TREATMENT OF SOURCES

This is an important concern to the individual emitter who is controlled more stringently than a neighboring or distant competitor. His costs, theoretically, are higher and he has a disadvantage in the marketplace. This is certainly a valid concern, but the concept of equity ought to be viewed more broadly to include external costs of environmental damage. If specific emitter A degrades the environment more severely than emitter B, thereby imposing greater social and economic burdens on society, one can agree that it is equitable that

he pay more than B to improve the situation (given that society dictates that the situation must somehow be improved). The point is that one can argue both sides of the issue and it is not clear, without additional analysis, which alternative is preferable from a societal point of view.

Another aspect of this issue deals with the equitable allocation of allowable air pollution emissions among and within specific emitter categories. One approach is to set an ambient air quality goal and to allocate emission rates in a localized area based upon the ambient effect of these emissions so that the desired air quality goal is achieved, or surpassed. Similar problems confront economic decision makers in setting fiscal policy. James A. Maxwell, for example, has described a familiar approach to setting flexible tax rates to balance the budget and possibly reduce the national debt based upon maintaining a high level of employment and national income[14]. The following correspondence among environmental and fiscal parameters suggests the abstract similarity in the structure of the two problems:

Structural Element	Environmental	Fiscal
Goals	Achieve ambient standards	Balance Budget, maintain high income and employment
Mechanism	Flexible emission rates	Flexible and graduated tax rates
Safeguards	Non-degradation	Debt retirement
External Influences	Variation in assimilative capacity of environment	Variation in GNP

One important point which causes the analogy to break down is that certain environmental impacts result in irreparable, irreversible changes

in the physical situation. The economy is man-made and, in a sense, artificial. It is not subject to irreversible changes of the same nature.

Allocation of emissions, implied by allowing variable emission standards, is in some ways analogous to allocation of block grants for a field such as public assistance.

Questions concerning how to set the maximum emissions (aggregate amount of assistance) and how to distribute the emissions (grants) are similar in each case. Maxwell suggested in 1955 that the distribution of the national aggregate in the form of block grants be set on the basis of minimum per capita expenditure. A standard effort for each state would be defined as a percent of the income payment raised and spent by the state. Poor states would not reach the per capita standard and would receive federal grants to meet the minimum goal. Some wealthier states may receive no supplementary federal grants. In this example the question of equity is based not on the fact that different states receive different amounts of federal grants, but that a minimum national per capita expenditure for public assistance is achieved for all citizens in the country.

The problems of environmental policy and standards are relatively recent national issues compared to the problems of fiscal and economic policy. Environmental problems require an understanding of the natural sciences and technology, utilizing fundamental principles of chemistry and physics and biology. The preceding discussion suggests that they also include allocation considerations which economic and fiscal policy

makers have been confronting over a longer period of time. Personnel from these disciplines could provide a fresh perspective for the scientifically oriented environmentalists in the formulation of environmental standards.

COMPLEXITY AND ADMINISTRATIVE COSTS

One often hears the argument that variable standards are more complex to administer and enforce than fixed standards. This may be true but, again, one should consider whether the benefits of variable standards (e.g., in regard to degree of environmental quality achieved, greater availability of low sulfur fuels, overall operating costs, economic dislocations) are greater than for fixed standards and if these benefits outweigh the possible higher administrative costs. Potential benefits in allowing more flexible emission standards are discussed in Section IV. It is generally accepted that our federal tax structure is inequitable in an absolute sense and highly complex. Yet, according to figures from the Internal Revenue Service, administrative costs amount to only 0.5 cents on each dollar collected[24]. This is not to say that they could not be lower if a less complex tax structure were adopted. Administrative costs do not appear to be the overriding issue associated with overhauling the tax structure. Voluntary compliance is an important reason for low administrative costs of the tax collection. This technique could also be employed in enforcement of emission standards. It has yet to be demonstrated from a cost-benefit point of view that administrative costs would eliminate consideration of variable environmental standards.

NATIONAL ECONOMY

American companies have manufacturing facilities in many parts of the country and sell their products in national and worldwide markets. If motor vehicle emission standards varied from state to state, this would require that the manufacturers adopt a variety of control devices to meet the different standards. Assuming these devices were developed and performed effectively it would probably not strain the industry's ingenuity to include another option in the assembly process. The combination of options already offered are in the thousands and multiplying these by a factor of four or five should pose no serious problems. But, relocation by individuals from one section of the country to another would constitute significant problems in insuring that their vehicles met local standards. The monetary cost of retrofit to the motorist could be significant, in addition to the inconveniences likely to be encountered.

SECTION III

GENERAL IMPACT OF VARIABLE AMBIENT STANDARDS

This section identifies some of the impacts of fixed vs. variable standards. The discussion is centered around air pollution standards because they have been fairly well developed and are currently controversial particularly as they affect the motor vehicle industry and fossil-fuel steam generating plants.

The national ambient standards for six primary air pollutants are designed to protect the public health and welfare. Questions have been raised concerning the values of the standard with respect to health risk. They may be changed as more health effects data become available, but variation on a geographic basis would require a change in the law.

A specific example of the drastic measures proposed to achieve the fixed ambient standard for oxidants[1] applies to the South Coast Air Basin which covers a major portion of Southern California including most of Los Angeles County[4]. In 1970, this standard was exceeded in some locations on 250 days. Ten percent of the readings taken in the basin were .40 ppm. There is clearly a serious problem in achieving the ambient standard. Uncontrolled emissions of reactive hydrocarbons, a major precursor of oxidant formation, is forecast by the EPA to be 691 tons/day in 1977. In order to meet the oxidant standard, EPA estimates that emissions must be reduced to 160 tons per day. A variety of controls have been proposed to meet this goal, the most dramatic of

[1] 160 $\mu g/m^3$ or .08 ppm for a one hour period not be exceeded more than once per year.

which involves a reduction of over 80% in vehicle miles traveled during critical periods f:om May to October. A mechanism to acheive this reduction would rely on rationing of gasoline by as much as 82%. Other actions would involve: a) installation of retrofit devices on all 1955 and newer vehicles (in 1972, there were about 6 million such vehicles in the area), 6) annual inspections and c) conversion of all 1971-1974 light and heavy duty vehciles in fleets of over 10 cars to use gaseous fuels. Controls on large drycleaning plants and solvent degreasing operations have also been proposed.

The economic and social impact of the proposals would include:

- Increased cost to vehicle owners ($200-$400 capital and $5-$15 annual maintenance) with particularly severe impact on low income groups
- Increased reliance on car-pooling and public transit
- Reduced mobility
- Potential loss of income due to decreased mobility
- Economic curtailment of automotive service and supply facilities
- Changes in property values
- Reduced taxes
- Potential development of effective rapid transit.

The total extent of these impacts are yet to be analyzed. Under the present provisions of the Clean Air Act the 10 million people in this section of the coutnry face a severe change in their current life style. A drastic reduction in economic viability is implied.

One can speculate on the potential impact that variable ambient standards might have on this kind of a situation. It is conceivable that a higher limit would be less restrictive, but it is not clear by what amount. Figure 3 shows two hypothetical relationships between hydrocarbon emission limits and oxidant concentrations. The EPA has estimated that at .08 ppm, the emissions must be at most 160 tons per day (point P, Figure 3). Beyond this point, curve B shows a more favorable emission allowance than curve A. If one were contemplating raising the oxidant standard from .08 to 0.15 ppm, then the emission limit would be 200 tons per day if curve A described the situation (point P') and 425 tons per day if curve B obtained (point P"). One might conclude that the increased risk represented by increasing the standard buys little relief under curve A, but provides significant relief under curve B. It would be desirable to quantify the risk as a function of the concentration to arrive at a proper balance of risk and impact and cost of limiting emissions.

Let us assume that curve B prevails and that at 0.15 ppm oxidant concentration there is little more noticeable effect than increased eye irritation. It is conceivable that the citizens in the area may opt for the greater risk associated with the higher standard in order to suffer a less severe curtailment on limitation of emissions. While a detailed analysis is required for obtaining precise quantitative estimates, it is safe to say that most adverse impacts (related to emission controls) listed above would be reduced. Suppose the limit

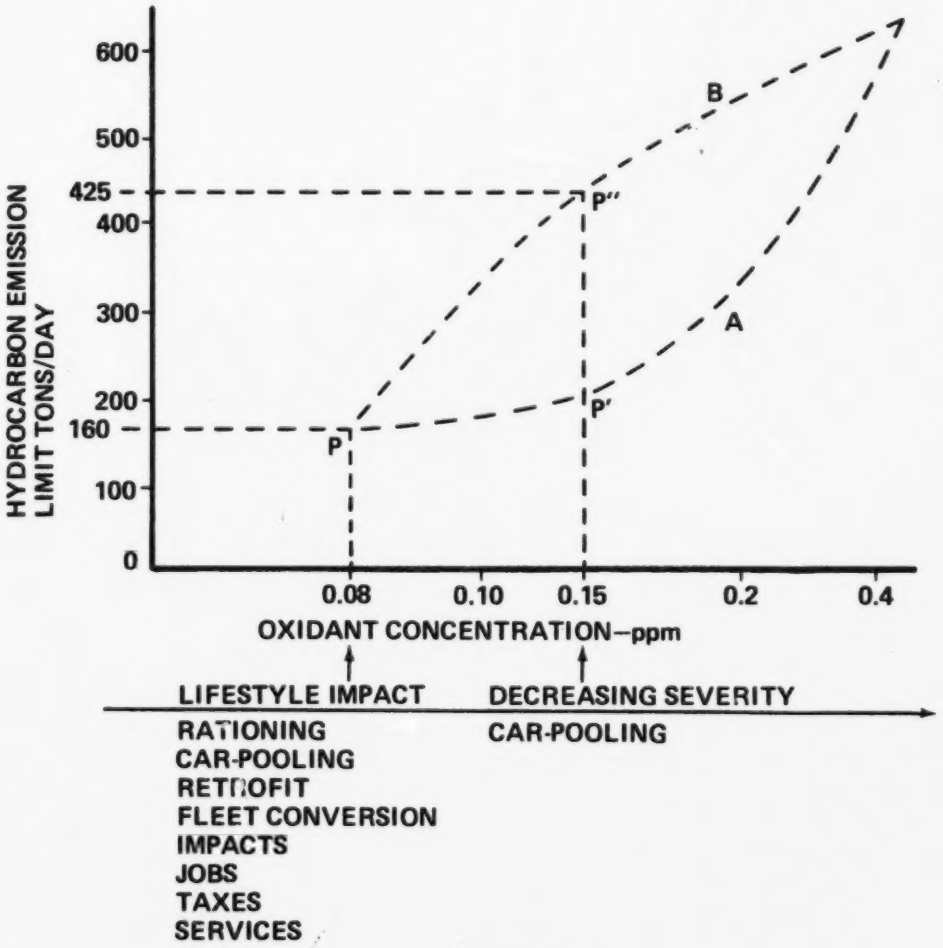

FIGURE 3

ILLUSTRATIVE RELATIONSHIPS - HYDROCARBON EMISSIONS
VS. AMBIENT OXIDANT CONCENTRATION

of 0.15 ppm might be achieved by increasing car pooling by 50%; this might represent a far more attractive option than living with the consequences of achieving a .08 ppm standard. As long as there is great uncertainty concerning precise health effects of various concentration levels, consideration of variable ambient standards on a geographical basis has some merit. No one would argue that the Los Angeles area has had acceptably clean air over the last 30 years. On the other hand, the general area has attracted 10 million people and offered some form of satisfaction of human needs.

People have long accepted risks associated with the automobile. Former Administrator Ruckelshaus has reported that 85% of the people surveyed in an opinion poll indicated that the consequences and risks related to the automobile - displacement of homes and business by highways, air pollution, noise, congestion, 2 million deaths and 10's of millions injured in this century - was worth the freedom of mobility. Perhaps the people in southern California may feel that they would prefer to preserve a significant portion of that freedom at the expense of relaxing the air quality standard[18]. Any such choice made by people in this area has to consider its impact on the people outside this area.

Acceptance of variable standards in different geographic areas might allow people to make a choice regarding where they may want to live based on a consideration of risk associated with air quality along with other economic and social factors. It appears, however, that environmental awareness does not yet play that prominent a role in making a

choice of residence. Financial constraints and economic opportunities probably are more significant factors. As pointed out in a recent report of the Advisory Committee on the Biological Effects of Ionizing Radiation[21],

> "...the annual difference in natural radiation between a location in Louisiana and one in Colorado might be 100 mrem or more. Even a person who knows this probably does not take this difference into account in deciding to change his residence."

One adverse impact of allowing variable ambient standards might be to drive industry into areas allowing higher (numerical) standards which are likely to be dirty and heavily populated areas. This would particularly occur if standards in a given area were set to allow degradation of the current ambient levels. To prevent areas with severe air pollution problems from getting worse and to discourage industries from seeking air pollution control havens, a non-degradation limit with respect to current ambient air quality might be imposed.

In new town development areas particularly, more stringent ambient standards might be promulgated on the basis of utilization of feasible new technology (e.g., emission controls, waste heat utilization, recycling) which might be planned, designed, and applied at the beginning to achieve a high level of environmental quality.

SECTION IV

GENERAL IMPACT OF VARIABLE EMISSION STANDARDS - STATIONARY SOURCES

Table VI shows that stationary source emission standards tend to be variable among source categories, but fixed among emitters within a specific category. Emission standards and regulations should be set on the basis of achieving an ambient level goal. Emission regulations prepared by the states are based on achieving ambient standards throughout an Air Quality Control Region based on the monitoring site having the highest ambient value in the Region. All emitters within a combustion source category for example, must burn fuel so as not to emit more than a maximum amount of sulfur per million BTU. This tactic often results in severe restrictions on some emitters who contribute relatively little degradation to air quality levels. In older urban areas, this may impose severe economic control costs on some plants in a rather arbitrary way. This may result in the abandoning of industries and residential apartment areas, creating hardship among the lower and middle income groups. Secondary effects may include intensifying social unrest in the form of increased delinquency, crime and dereliction. A combination of allowing flexible ambient standards along with more selective application of controls may allow these areas to be maintained as viable economic and social areas.

The implementation of variable emission standards is interrelated with strategies for emission controls. There are basically two types of strategies; fixed and intermittent.

Fixed Strategies

Fixed strategies in pollution control consist of techniques such as process modification, time variance in implementation of regulations and selective control of sources whose emissions constitute the greatest degradation to ambient air quality.

There have been several studies whose results tend to support greater flexibility in emission standards and application fo control strategies. Plotkin and Lewis have compared the application of uniform emission standards to source categories with a least cost selective control strategy (based on a linear programming model) for the St. Louis Airshed[17]. The least cost approach achieves a minimum cost of control by applying the most stringent controls to sources which contribute most to air quality degradation or whose marginal control costs are low, or both. The uniform emission control strategy, according to the analysis, would cost $10.4 million annually while the least cost strategy would cost $6 million. The ground level concentrations for the least cost strategy were higher than for the uniform emissions strategy. The additional benefits of uniform controls were not computed to relate them to the additional $4.4 million annual cost. Additional analysis performed by the EPA recently for the St. Louis area indicates a cost reduction factor of 3-6 for selective control (with respect to fixed emission standards) depending on the emission level[11].

Results of a study for three Air Quality Control Regions conducted by Krajeski and Yeager[9], show that 75% effective control applied to a

relatively small number of emitters on a selective basis would result in achievement of the primary SO_2 standard. A summary of these results for the three areas is shown in Table VII. For example, control of 300 emitters at 75% effectiveness in the New York area reduces overall emissions by 64% and achieves the ambient level at all receptors. A further breakdown of the emitter categories for New York is shown in Table VIII. All emission requiring control are combustion in origin. Since the New York area may be using 5 million tons of coal and 215 million barrels of residual fuel oil annually, less stringent emission controls on 36 percent of the fuels would provide a substantial contribution in reducing projected clean fuel deficits. These savings in clean fuel might be extended on a national basis. Furthermore, allowing variability of extent of controls within and among source categories might allow even further economies.

Another alternative to allow more flexibility in emissions has been a proposed emissions tax. Many investigators have examined the implication of an emission tax which, if set at a proper rate, would provide an incentive to minimize operating costs and reduce emissions. Tax revenues could be applied toward developing better control technology and alleviating damage costs[7,12,19,22,23].

There seems to be the hope that increased flexibility might allow most areas in the country to realize the goal of achieving clean air standards with minimal imposition of economic and social dislocation.

TABLE VII

SUMMARY OF SELECTIVE CONTROL STRATEGY APPLIED TO THREE AQCR'S

AQCR	NO. OF EMISSION SOURCES	NO. OF EMITTERS CONTROLLED AT 75% EFFECTIVENESS	% OF EMISSIONS REQUIRING CONTROL
New York	1,285	300	64
Philadelphia	700	53	19
Niagra Frontier	541	17	27

TABLE VIII

SELECTIVE REDUCTION OF SO_x EMISSIONS TO ACHIEVE 80 $\mu g/m^3$

NEW YORK AQCR

EMITTER CATEGORY	PRESENT EMISSIONS SOURCES	TONS/DAY (A)	UNCONTROLLED EMISSIONS FROM SOURCES REQUIRING CONTROL AT 75% SOURCES	TONS/DAY (B)	TOTAL CONTROLLED EMISSIONS SOURCES	TONS/DAY (C)
Industrial Combustion	106	238	14	111	106	155
Industrial Process	42	79	0	0	42	79
Utility Power	31	1,389	21	1,039	31	610
Area Sources	1,106	2,020	265	1,248	1,106	1,084
TOTAL	1,285	3,726	300	2,398	1,285	1,928

$C = .25B + (A-B)$

Intermittent Strategies

Air quality is generally a function of emissions, assimilative capacity of the environment, control strategies and background levels. The dynamic interplay of these parameters constitutes an intermittent control strategy. Examples of these include[25]:

- Load Switching (e.g., drawing power from outside an area which is experiencing low assimilative capabity).
- Work Pattern Modification (e.g., staggering of work schedules).
- Fuel Switching (by sulfur quality or by type, i.e., coal to oil).

Criteria for evaluating intermittent control systems, based on meteorological conditions have been developed by EPA[5]. Fuel and load switching strategies (seasonally, daily) to minimize use of low sulfur fuels while still achieving ambient standards have been described in several studies[1,6,13]. The Tennessee Valley Authority has had experience in investigating applications of fuel and load switching techniques based upon meteorological conditions at the Paradise Steam Plant. Development cost (e.g., for necessary pollutant and air monitoring equipment, data handling, programming, vehicles, test equipment) were estimated at $262 thousand and annual operating costs (e.g., personnel, data processing, maintenance) were estimated at $103 thousand[10,20].

Ward has made a gross estimate of the national impact of applying a fuel quality switching strategy[25] (i.e., switching from low sulfur to high sulfur content coal or low sulfur to high sulfur oil during days of good ventilation or high assimilative capacity). An analysis of Air Pollution Potential Advisories issued by the National Weather Service indicates that 80 percent of the time it would be possible to burn high sulfur content fuel because the assimilative capacity of the atmosphere is high. In 1970, steam electric plants consumed 328 million tons of coal and 287 million barrels of oil. About two-thirds of the total power generated from plants which burned coal (either exclusively or in combination with gas or oil), was generated by plants which burned coal exclusively. It may be possible, therefore, for power plants to burn as much as

$$(328 \times 10^6)(2/3)(.8) = 176 \text{ million tons}$$

of higher sulfur coal based on 1970 consumption. Because of concentration of plants in populated areas, low sulfur coal must probably be burned even on some days with good ventilation in order to achieve ambient standards. Even if 25 percent of this estimate is realizable, it would save about 44 million tons of low sulfur coal out of a projected deficit ranging from under 100 million up to 250 million tons. Assuming a price differential of $5 per ton between low sulfur and high sulfur coal, this represents a fuel cost savings to the utilities and to consumers of about $220 million annually.

About thirty percent of the total generating capacity of plants which burn oil to some extent is generated by plants which burn oil exclusively. A similar analysis as the one described for coal, above, indicates a maximum potential of burning 71 million barrels of high sulfur oil on good ventilation days. Again, assuming that 25 percent is actually attainable, a potential switch from low to high sulfur oil by utilities might produce savings amounting to about 18 million barrels per year. Assuming an average of $1.25 difference per barrel between low and high sulfur oil, an annual fuel cost savings of $22.5 million might be realized. The low sulfur fuel would be available for use by area sources whose emissions generally have a relatively high impact on ambient air quality.

The price for the fuel savings is paid by the utilities in that they must install and operate the necessary forecasting and monitoring systems to allow implementation of the strategy. About 1000 plants burn coal or oil exclusively. If as many as a half of these installed and operated the necessary intermittent control system monitoring equipment and processing facilities, the total development cost would be about $131 million and the total operating cost would be $51.5 million annually, according to the TVA experience[20]. The development cost would be recovered within one year by the savings in fuel costs, with an additional potential annual savings relizable amounting to $190 million.

While this paper does not provide a rigorous analysis of these options, the gross results imply that they are promising possibilities if they are confirmed by a more detailed study.

SECTION V

CONCLUDING REMARKS

This paper has illustrated some types of potential impacts which are associated with implementation of environmental standards which are characterized by varying degrees of flexibility. Variable standards should not be interpreted as allowing spurious and arbitrary changes on a frequent basis. This would not be accpetable to the general public and would create uncertainty and distrust of the standard setting and enforcement process by the industrial and commercial segments of our society. There are many opportunities to allow for implementation of more flexible standards in order to achieve environmental quality goals on an economical basis, particularly for emissions and effluent discharges. These opportunities must be explored and selected through systems analysis of interrelationships among control technology and environmental social and economic impacts. Related issues seem to be forming around apparent conflicts in obtaining an improved environment with its associated health and welfare benefits and an improved living standard associated with abundant energy production and consumption. Improving both will result in an improvement in the overall quality of life. The question of fixed vs. variable standards should be examined in the hope of minimizing or eliminating the apparent conflict.

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